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10/730,533	12/08/2003	Chung-Hsing Chang	NI085-00018	4276

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EXAMINER
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RUGGLES, JOHN S

ART UNIT	PAPER NUMBER
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1756

DATE MAILED: 03/24/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/730,533

Applicant(s)

CHANG ET AL.

Examiner

John Ruggles

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 18 January 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-22 is/are pending in the application.
- 4a) Of the above claim(s) 17-22 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-16 is/are rejected.
- 7) ☒ Claim(s) 2-5, 7, 8 and 10-16 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 5/7/04 & 12/8/03 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date <u>12/8/03</u> . | 6) <input type="checkbox"/> Other: _____  |

**DETAILED ACTION*****Election/Restrictions***

Applicants' election with traverse of Group II claims 9-16 in the reply filed on 1/18/06 is acknowledged. The traversal is on the ground(s) that there is no serious burden for examination of Group I claims 1-8 along with the elected Group II claims 9-16. This is found persuasive and claims 1-8 are rejoined for examination along with the elected claims 9-16. Claims 17-22 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to nonelected inventions. Therefore, only claims 1-16 are under consideration.

***Drawings***

New corrected drawings in compliance with 37 CFR 1.121(d) are required in this application, because both the original drawings filed on 12/8/03 and the amended drawings filed on 5/7/04 are informal, and are not sufficiently clear (e.g., to allow clear reproduction thereof, etc.). Applicants are advised to employ the services of a competent patent draftsman outside the Office, as the U.S. Patent and Trademark Office no longer prepares new drawings. The corrected drawings are required in reply to the Office action to avoid abandonment of the application. The requirement for corrected drawings will not be held in abeyance.

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: (A) "484" shown in Figure 4, (B) "505", "550", and "560" shown in Figure 5, and (C) "670", "680", and "690" shown in Figure 6 are not found in the corresponding descriptions thereof in paragraphs [0027-0028] on page 7 and [0029-0030] on page 8, respectively, of the original specification filed on 12/8/03. Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the

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specification to add the reference character(s) in the description in compliance with 37 CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

### *Specification*

The substitute specification filed on 5/7/04 has not been entered because it does not conform to 37 CFR 1.125(b) and (c) for at least the following reasons: the substitute specification clean copy was not accompanied by both (1) a statement for the record that it does not contain any new matter, as required by 37 CFR 1.125(b), and (2) a corresponding marked-up version showing all changes relative to the immediate prior version of the specification of record filed on 12/8/03, as required by 37 CFR 1.125(c).

The title of the invention is not fully descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. The original specification (e.g., in paragraph [0018] lines 3-4, etc.) describes the instant patterned phase shifting mask (PSM) to be formed without any chrome. Also, the word "type" is indefinite and should be deleted from the title. Furthermore, the elected claims include methods of manufacturing the PSM.

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In order to resolve these issues, the following amended title is suggested: --CLEAR  
FIELD ANNULAR [[TYPE]] CHROMELESS PHASE SHIFTING MASK AND METHODS  
OF MANUFACTURING THE SAME--.

Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

The abstract of the disclosure is objected to because: (1) in lines 2 and 4-6, "said" should be corrected to --[[said]] the--, at each occurrence throughout the abstract; (2) in line 5, "patterning said pattern onto said mask substrate; removing" should be changed to --patterning [[said]] the resist layer pattern onto [[said]] the mask substrate; and removing--; and (3) in line 8, "an opaque region on a semiconductor substrate" should also be changed (e.g., to --~~an opaque a~~ dark region on a semiconductor substrate--, etc.). Correction is required. See MPEP § 608.01(b).

35 U.S.C. 112, first paragraph, requires the specification to be written in "full, clear, concise, and exact terms." The specification is replete with terms, which are not clear, concise and exact. The specification should be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some unclear, inexact or verbose terms used in the specification are: (1) in paragraph [0003] lines 4-5, "are added onto the mask reduce diffraction effects" should be changed to --are added onto the mask to reduce diffraction effects--; (2) in [0003] lines

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9-10, “near a feature edge to in order to improve image resolution” should be corrected to --near a feature edge [[to]] in order to improve image resolution--; (3) in [0007] lines 4-5, “molybdenum silicide ( $\text{MoSiO}_x\text{N}_y$ )” (in line 4) should be changed to --molybdenum silicide oxynitride ( $\text{MoSiO}_x\text{N}_y$ )-- and “molybdenum silicide” (in line 5) should be changed to --molybdenum silicide oxynitride--, in order to better correspond with the chemical formula given in line 4; and (4) in [0027] line 8, “depth of focus (“DOE”)” should be corrected to --depth of focus (“~~DOE~~”) (“DOF”)--. Note that due to the number of errors, those listed here are merely examples of the corrections needed and do not represent an exhaustive list thereof.

Appropriate correction is required. An amendment filed making all appropriate corrections must be accompanied by a statement that the amendment contains no new matter and also by a brief description specifically pointing out which portion of the original specification provides support for each of these corrections.

### ***Claim Objections***

Claims 2-5, 7-8, and 10-16 are objected to because of the following informalities: (1) in claims 2, 4, 7-8, and 13-16 “said pattern” should be changed to --said at least one annular equal line space phase shifting pattern--, at each occurrence; (2) in both claim 3 line 2 and claim 5 lines 2-4, “degrees from” should be changed to --degrees from that of--, at each occurrence; and (3) in claim 10, the lines should be renumbered as --[[7-10]] 1-9--. Claim 3 depends on claim 2, claim 5 depends on claim 4, and claims 11-16 depend on claim 10. Appropriate correction is required.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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Claims 1-16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 1, the term “opaque” in claim 1 is used by the claim to mean --dark-- or --unexposed--, while the accepted meaning is “not pervious to radiant energy and especially light” (as shown by Webster’s Ninth New Collegiate Dictionary, 1986, Merriam-Webster Inc., page 826, a copy of which is attached to this Office action). However, for the purpose of this Office action and in order to advance the prosecution of this application, the intended use for the claimed phase shifting mask (PSM) is not understood to produce an “opaque” region that is not transparent to light on the semiconductor substrate, but rather is interpreted to mean that the intended use of the claimed PSM is to produce a --dark-- or --unexposed-- region on the semiconductor substrate (intended by a darkening effect from destructive interference between adjacent opposite phases of light produced from the PSM). Claims 2-8 depend on claim 1.

In claim 9 line 4 and in claim 10 line 11 (which is actually the 5<sup>th</sup> line of claim 10), it is unclear how a resist layer could be patterned to form “at least one equal line space **phase shifting** pattern” (emphasis added) that would necessarily have to be transparent to light of one phase where the resist is patterned and another (opposite) phase where the resist is not patterned. However, for the purpose of this Office action and in order to advance the prosecution of this application, each of claims 9 and 10 have been interpreted to mean that the “at least one equal line space **phase shifting** pattern” is *not* actually formed from the resist layer, but rather with the mask substrate itself (by e.g., etching the mask substrate as recited in claim 15 or coating additional phase shifting material on the mask substrate as recited in claim 16, etc.). Claim 9

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lines 4-5 are interpreted as follows: --~~patterning at least one equal line space phase shifting pattern on~~ said resist layer; ~~patterning said pattern onto~~ at least one equal line space phase shifting pattern on said mask substrate through the patterned resist layer;--. Claim 10 lines 11-14 (which are actually the 5<sup>th</sup> through the 8<sup>th</sup> lines of claim 10) are interpreted as follows: --~~patterning at least one equal line space phase shifting pattern on~~ said resist layer; ~~patterning said pattern onto~~ said conductive layer through the patterned resist layer; removing a remaining portion of said resist layer; ~~patterning said pattern onto~~ at least one equal line space phase shifting pattern on said mask substrate through the patterned conductive layer;--. Claims 11-16 depend on claim 10.

### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-8 are rejected under 35 U.S.C. 102(e) as being anticipated by Sivakumar et al. (2004/0101765).

Sivakumar et al. teach chromeless phase shift lithography (CPL) masks (chromeless PSMs) and methods of using them for patterning large line/space geometries (title, abstract). CPL masks have adjacent transparent 0° non-PS regions and 180° PS regions to generate a phase edge between the PS and non-PS regions that is darkened in the resist aerial image by destructive interference of light diffracted from the 0° and 180° regions immediately on either side of the



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phase edge (paragraph [0003], instant claims 3, 5, and 7). The PS features can be recesses or mesas patterned on a quartz mask substrate (instant claim 6, e.g., by etching, etc. [0026]). Figure 6D (Option D) shows a chromeless PSM having a “bulls eye” configuration including a central PS square portion 604 that is surrounded by a first annular non-PS ring 608, which is further surrounded by another outer annular PS ring 606 [0029]. The Figure 6D chromeless PSM is very similar to that shown by instant Figure 1A. The interspersed or alternating PS and non-PS regions (including the central square and surrounding annular rings that make up an annular equal line space PS pattern) are each physically small enough and placed close enough together to ensure that the aerial images of the individual features merge to provide a combined aerial image capable of patterning a large resist structure ([0030], that is darkened or unexposed on the resist, reading on instant claims 1-2 and 4). To produce an ideal deep single minimum aerial image intensity on a resist using 193 nm exposure light, the phase edge separation or the line width on the chromeless PSM should be  $0.1\mu\text{m}$  (100nm [0004], corresponding to a pitch on the mask ( $P_m$ ) of 200nm for PS lines separated by an intermediate non-PS line of the same width as the PS lines). An exemplary modern integrated circuit (IC) has lines with a base width (or critical dimension) of  $0.25\mu\text{m}$  (250nm [0025], corresponding to a resist image (e.g., on a semiconductor substrate, etc.) having a pitch ( $P_{cs}$ ) of 500nm). Applying  $P_m=200\text{nm}$  and  $P_{cs}=500\text{nm}$  for a common 4X mask ( $N=4$ ) to the instant expression  $P_m < N \times 2P_{cs}$  (instant [0023] for a mask pattern pitch smaller than two times a corresponding critical dimension pitch on a semiconductor substrate, as recited by instant claim 8) would yield  $200\text{nm} < 4 \times 2 (500\text{nm})$  or  $200\text{nm} < 4,000\text{nm}$  (reading on instant claim 8).

***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 9-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sivakumar et al. (2004/0101765) in view of either Dao et al. (5,302,477) or Schroeder et al. (2003/0027057).

While teaching other aspects of the instant claims including selective etching of an annular equal line space pattern in a quartz substrate for a chromeless PSM, as discussed above, Sivakumar et al. do not specifically teach patterning a resist layer on the PSM substrate before etching through the patterned resist layer and removing the remaining resist layer after etching (instant claim 9). Also, Sivakumar et al. do not specifically teach using a conductive chrome layer (e.g., as an etching mask, etc.) between the PSM substrate and the patterned resist to manufacture the PSM (instant claim 10).

Dao et al. teach an inverted phase-shifted reticle or mask (PSM) having adjacent inverted phase features with PS rims or phase edges between 0° and 180° phase features; and methods of fabricating the PSM (title, abstract). The methods of fabricating the PSM include performing patterning or etching of a (conductive) chrome (Cr) mask layer 21 (instant claim 12) formed on a transparent quartz substrate 20 (as shown in Figure 7, instant claim 11) through an overlying patterned photoresist or resist layer 51, patterning or etching of the quartz substrate 20 through the patterned Cr 21, and removing remaining resist layer 51 (as shown in Figure 8, col. 8 lines 46-69). A remaining portion of the Cr 21 is also removed (as shown in Figures 9 and 10, which

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is a cross-sectional view of the annular ring patterned PSM shown in Figure 5A, col. 9 lines 9-12, instant claim 10). An alternative method includes directly etching the PSM transparent quartz substrate 20 through an overlying patterning layer 125 (e.g., of resist, etc.) followed by removal of the remaining patterning or resist layer 125 (as shown in Figures 27 and 28, col. 11 lines 36-57, instant claim 9).

Schroeder et al. teach a phase shift mask 400 (PSM) and method of manufacturing the PSM (abstract). Figure 6A shows a PSM 400 having a transparent quartz substrate 402 (instant claim 11) with a first etched region 458 for a  $180^\circ$  phase feature and adjacent second unetched region 460 for a  $0^\circ$  phase feature (paragraphs [0041-0047]). In the method of manufacturing the PSM, a (conductive) chrome (Cr) layer 404 (instant claim 12) is preferably formed on the transparent substrate and patterned before etching of the underlying transparent substrate [0043]. The method for making the PSM in Figure 6A would be expected to involve patterning of an opening in the Cr layer through an overlying patterning layer (e.g., of resist, etc.), removal of remaining patterning or resist layer, etching of the underlying transparent substrate at a first region 458 through the opening in the Cr layer, and removal of a remaining portion of the Cr layer that forms a second adjacent region 460 (instant claim 10). Alternatively, the method of making the PSM can exclude the use of a Cr layer 404 ([0043] lines 4-5, which suggests that the PSM transparent quartz substrate 402 can be etched directly through an overlying patterning layer (e.g., of resist, etc.) followed by removal of the remaining patterning or resist layer, instant claim 9).

It would have been obvious to one of ordinary skill in the art at the time of the invention to manufacture the chromeless PSM including a central portion and surrounding annular rings

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that make up an annular equal line space PS pattern taught by Sivakumar et al. by etching PS features between non-PS features into the transparent substrate of the chromeless PSM either directly through an overlying patterned resist or indirectly through an overlying patterned resist and intermediate patterned or etched Cr layer, as exemplified by either Dao et al. or Schroeder et al. This is because both of these direct and indirect etching methods for manufacturing etched phase shifters in a transparent mask substrate to make a PSM have been well known in the art for some time, as exemplified by either Dao et al. or Schroeder et al. (instant claims 9-15).

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sivakumar et al. (2004/0101765) in view of Lee et al. (5,240,796).

While teaching other aspects of the instant claim including selective patterning of an annular equal line space pattern on a quartz substrate for a chromeless PSM, as discussed above, Sivakumar et al. do not specifically teach disposing added phase shifting (PS) material on the mask substrate through a patterned conductive layer (e.g., as a coating mask, etc.).

However, Lee et al. teach a method that has been known for some time to fabricate a chromeless phase shift reticle or mask (chromeless PSM) having a pattern of added PS material portions at a thickness to achieve a PS of  $180^\circ$  for light passing through the PS portions relative to light transmitted through non-PS ( $0^\circ$ ) portions of the transparent mask substrate (title, abstract, issue date). The method includes depositing a conductive or metallic layer 40 (e.g., of Cr, etc.) on a transparent mask substrate 30 (e.g., of quartz, etc.), forming a photoresist or resist layer 44 on the conductive Cr layer (as shown in Figure 3A, col. 4 line 61 to col. 5 line 38), patterning the resist layer 44, anisotropic dry etching of the Cr layer to form patterned portions 48 with openings 46 having vertical sidewalls, and removing the remaining resist layer 44 (as shown in

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Figure 3B, col. 5 lines 38-51). Next, a PS material 50 (e.g., of silicon dioxide ( $\text{SiO}_2$ ), silicon nitride ( $\text{SiN}$ ), etc.) is blanket or conformally deposited on the patterned conductive Cr layer 48 to fill the openings 46 therein (as shown in Figure 3C, col. 5 line 52 to col. 6 line 7). Then, the PS material 50 is planarized down to the same thickness as the patterned conductive Cr layer 48 (as shown in Figure 3D, col. 6 lines 8-13) followed by etching away the patterned conductive Cr 48 to form patterned PS portions 52 having vertical sidewalls with intervening transmissive areas 54 on the transparent mask substrate (as shown in Figure 3E, col. 6 lines 29-37, which reads on instant claim 16).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to manufacture the chromeless PSM including a central portion and surrounding annular rings that make up an annular equal line space PS pattern (as taught by Sivakumar et al.) by patterning added PS features (instead of etching PS features) between non-PS features on the transparent substrate of the chromeless PSM through an overlying patterned resist and an intermediate patterned or etched temporary conductive Cr layer as a coating mask, in order to achieve vertical sidewalls for added PS features on the chromeless PSM (which has been known in the art of making chromeless PSMs for some time, as taught by Lee et al.).

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 571-272-1390. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 571-272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



John Ruggles  
Examiner  
Art Unit 1756



S. ROSASCO  
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